

# Self-Protected Low Side Driver with Temperature and Current Limit

## NCV8401A, NCV8401B

NCV8401A/B is a three terminal protected Low-Side Smart Discrete device. The protection features include overcurrent, overtemperature, ESD and integrated Drain-to-Gate clamping for overvoltage protection. This device offers protection and is suitable for harsh automotive environments.

### Features

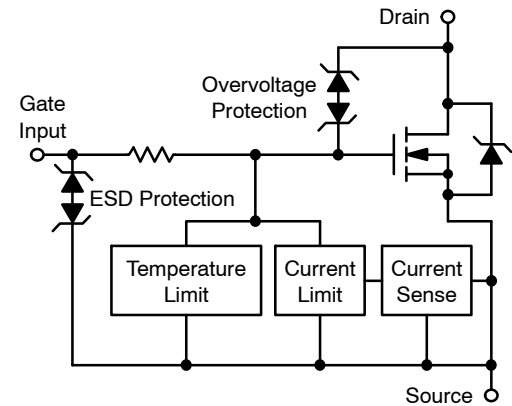
- Short Circuit Protection
- Thermal Shutdown with Automatic Restart
- Over Voltage Protection
- Integrated Clamp for Inductive Switching
- ESD Protection
- dV/dt Robustness
- Analog Drive Capability (Logic Level Input)
- NCV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q101 Qualified and PPAP Capable
- These Devices are Pb-Free and are RoHS Compliant

### Typical Applications

- Switch a Variety of Resistive, Inductive and Capacitive Loads
- Can Replace Electromechanical Relays and Discrete Circuits
- Automotive / Industrial

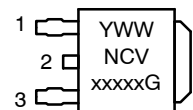
V <sub>DSS</sub> (Clamped)	R <sub>DS(ON)</sub> TYP	I <sub>D</sub> MAX (Limited)
42 V	23 mΩ @ 10 V	33 A*

\*Max current may be limited below this value depending on input conditions.



DPAK  
CASE 369C  
STYLE 2

### MARKING DIAGRAM



Y = Year  
WW = Work Week  
xxxxx = 8401A or 8401B  
G = Pb-Free Package

1 = Gate  
2 = Drain  
3 = Source

### ORDERING INFORMATION

Device	Package	Shipping <sup>†</sup>
NCV8401BDTRKG	DPAK (Pb-Free)	2500 / Tape & Reel

### DISCONTINUED (Note 1)

NCV8401ADTRKG	DPAK (Pb-Free)	2500 / Tape & Reel
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<sup>†</sup>For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specification Brochure, BRD8011/D.

1. **DISCONTINUED:** This device is not recommended for new design. Please contact your **onsemi** representative for information. The most current information on this device may be available on [www.onsemi.com](http://www.onsemi.com).

# NCV8401A, NCV8401B

## MAXIMUM RATINGS ( $T_J = 25^\circ\text{C}$ unless otherwise noted)

Rating	Symbol	Value	Unit
Drain-to-Source Voltage Internally Clamped	$V_{\text{DSS}}$	42	V
Drain-to-Gate Voltage Internally Clamped ( $R_{\text{GS}} = 1.0 \text{ M}\Omega$ )	$V_{\text{DGR}}$	42	V
Gate-to-Source Voltage	$V_{\text{GS}}$	$\pm 14$	V
Drain Current – Continuous	$I_{\text{D}}$	Internally Limited	
Total Power Dissipation @ $T_A = 25^\circ\text{C}$ (Note 1) @ $T_A = 25^\circ\text{C}$ (Note 2)	$P_{\text{D}}$	1.1 2.0	W
Thermal Resistance, Junction-to-Case Junction-to-Ambient (Note 1) Junction-to-Ambient (Note 2)	$R_{\theta\text{JC}}$ $R_{\theta\text{JA}}$ $R_{\theta\text{JA}}$	1.6 110 60	$^\circ\text{C/W}$
Single Pulse Drain-to-Source Avalanche Energy ( $V_{\text{DD}} = 25 \text{ Vdc}$ , $V_{\text{GS}} = 5.0 \text{ Vdc}$ , $I_{\text{L}} = 3.65 \text{ Apk}$ , $L = 120 \text{ mH}$ , $R_{\text{G}} = 25 \Omega$ , $T_{\text{Jstart}} = 150^\circ\text{C}$ ) (Note 3)	$E_{\text{AS}}$	800	mJ
Load Dump Voltage ( $V_{\text{GS}} = 0$ and $10 \text{ V}$ , $R_{\text{I}} = 2.0 \Omega$ , $R_{\text{L}} = 3.0 \Omega$ , $t_{\text{d}} = 400 \text{ ms}$ )	$V_{\text{LD}}$	65	V
Operating Junction Temperature	$T_{\text{J}}$	-40 to 150	$^\circ\text{C}$
Storage Temperature	$T_{\text{stg}}$	-55 to 150	$^\circ\text{C}$

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. Minimum FR4 PCB, steady state.
2. Mounted onto a 2" square FR4 board  
(1" square, 2 oz. Cu 0.06" thick single-sided,  $t = \text{steady state}$ ).
3. Not subject to production testing.

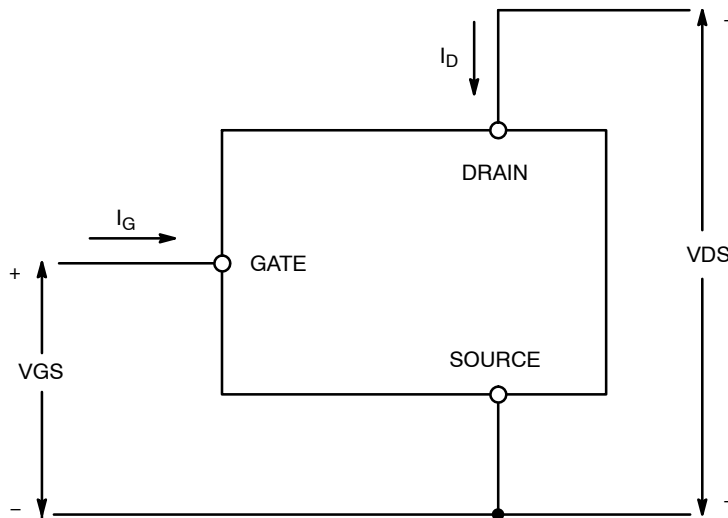


Figure 1. Voltage and Current Convention

# NCV8401A, NCV8401B

## MOSFET ELECTRICAL CHARACTERISTICS ( $T_J = 25^\circ\text{C}$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
<b>OFF CHARACTERISTICS</b>					
Drain-to-Source Clamped Breakdown Voltage ( $V_{GS} = 0\text{ Vdc}$ , $I_D = 250\text{ }\mu\text{Adc}$ ) ( $V_{GS} = 0\text{ Vdc}$ , $I_D = 250\text{ }\mu\text{Adc}$ , $T_J = 150^\circ\text{C}$ ) (Note 4)	$V_{(BR)DSS}$	42 42	46 44	50 50	Vdc
Zero Gate Voltage Drain Current ( $V_{DS} = 32\text{ Vdc}$ , $V_{GS} = 0\text{ Vdc}$ ) ( $V_{DS} = 32\text{ Vdc}$ , $V_{GS} = 0\text{ Vdc}$ , $T_J = 150^\circ\text{C}$ ) (Note 4)	$I_{DSS}$		1.5 6.5	5.0	$\mu\text{Adc}$
Gate Input Current ( $V_{GS} = 5.0\text{ Vdc}$ , $V_{DS} = 0\text{ Vdc}$ )	$I_{GSSF}$		50	100	$\mu\text{Adc}$

## ON CHARACTERISTICS

Gate Threshold Voltage ( $V_{DS} = V_{GS}$ , $I_D = 1.2\text{ mAdc}$ ) Threshold Temperature Coefficient	$V_{GS(th)}$	1.0	1.8 5.0	2.0	Vdc -mV/ $^\circ\text{C}$
Static Drain-to-Source On-Resistance (Note 5) ( $V_{GS} = 10\text{ Vdc}$ , $I_D = 5.0\text{ Adc}$ , $T_J @ 25^\circ\text{C}$ ) ( $V_{GS} = 10\text{ Vdc}$ , $I_D = 5.0\text{ Adc}$ , $T_J @ 150^\circ\text{C}$ ) (Note 4)	$R_{DS(on)}$		23 43	29 55	m $\Omega$
Static Drain-to-Source On-Resistance (Note 5) ( $V_{GS} = 5.0\text{ Vdc}$ , $I_D = 5.0\text{ Adc}$ , $T_J @ 25^\circ\text{C}$ ) ( $V_{GS} = 5.0\text{ Vdc}$ , $I_D = 5.0\text{ Adc}$ , $T_J @ 150^\circ\text{C}$ ) (Note 4)	$R_{DS(on)}$		28 50	34 60	m $\Omega$
Source-Drain Forward On Voltage ( $I_S = 5\text{ A}$ , $V_{GS} = 0\text{ V}$ )	$V_{SD}$		0.80	1.1	V

## SWITCHING CHARACTERISTICS (Note 4)

Turn-ON Time (10% $V_{IN}$ to 90% $I_D$ )	$V_{IN} = 0\text{ V to } 5\text{ V}$ , $V_{DD} = 25\text{ V}$ $I_D = 1.0\text{ A}$ , Ext $R_G = 2.5\text{ }\Omega$	$t_{ON}$	41	50	$\mu\text{s}$
Turn-OFF Time (90% $V_{IN}$ to 10% $I_D$ )		$t_{OFF}$	129	150	
Turn-ON Time (10% $V_{IN}$ to 90% $I_D$ )	$V_{IN} = 0\text{ V to } 10\text{ V}$ , $V_{DD} = 25\text{ V}$ $I_D = 1.0\text{ A}$ , Ext $R_G = 2.5\text{ }\Omega$	$t_{ON}$	16	25	$\mu\text{s}$
Turn-OFF Time (90% $V_{IN}$ to 10% $I_D$ )		$t_{OFF}$	164	180	
Slew-Rate ON (80% $V_{DS}$ to 50% $V_{DS}$ )	$V_{in} = 0\text{ to } 10\text{ V}$ , $V_{DD} = 12\text{ V}$ , $R_L = 4.7\text{ }\Omega$	$-dV_{DS}/dt_{ON}$	1.27	2.0	V/ $\mu\text{s}$
Slew-Rate OFF (50% $V_{DS}$ to 80% $V_{DS}$ )		$dV_{DS}/dt_{OFF}$	0.36	0.75	

## SELF PROTECTION CHARACTERISTICS ( $T_J = 25^\circ\text{C}$ unless otherwise noted)

Current Limit	$V_{GS} = 5.0\text{ V}$ , $V_{DS} = 10\text{ V}$ $V_{GS} = 5.0\text{ V}$ , $T_J = 150^\circ\text{C}$ (Notes 4, 6)	$I_{LIM}$	25 11	30 16	35 21	Adc
	$V_{GS} = 10\text{ V}$ , $V_{DS} = 10\text{ V}$ $V_{GS} = 10\text{ V}$ , $T_J = 150^\circ\text{C}$ (Notes 4, 6)		30 18	35 25	40 28	
Temperature Limit (Turn-off)	$V_{GS} = 5.0\text{ V}$ (Notes 4, 6)	$T_{LIM(off)}$	150	175	200	$^\circ\text{C}$
Thermal Hysteresis	$V_{GS} = 5.0\text{ V}$	$\Delta T_{LIM(on)}$		15		$^\circ\text{C}$
Temperature Limit (Turn-off)	$V_{GS} = 10\text{ V}$ (Notes 4, 6)	$T_{LIM(off)}$	150	165	185	$^\circ\text{C}$
Thermal Hysteresis	$V_{GS} = 10\text{ V}$	$\Delta T_{LIM(on)}$		15		$^\circ\text{C}$

## GATE INPUT CHARACTERISTICS (Note 4)

Device ON Gate Input Current	$V_{GS} = 5\text{ V}$ , $I_D = 1.0\text{ A}$	$I_{GON}$		50	100	$\mu\text{A}$
	$V_{GS} = 10\text{ V}$ , $I_D = 1.0\text{ A}$			400	700	
Current Limit Gate Input Current	$V_{GS} = 5\text{ V}$ , $V_{DS} = 10\text{ V}$	$I_{GCL}$		0.1	0.5	mA
	$V_{GS} = 10\text{ V}$ , $V_{DS} = 10\text{ V}$			0.7	1.0	
Thermal Limit Fault Gate Input Current	$V_{GS} = 5\text{ V}$ , $V_{DS} = 10\text{ V}$	$I_{GTL}$		0.6	1.0	mA
	$V_{GS} = 10\text{ V}$ , $V_{DS} = 10\text{ V}$			2.0	4.0	

## ESD ELECTRICAL CHARACTERISTICS ( $T_J = 25^\circ\text{C}$ unless otherwise noted) (Note 4)

Electro-Static Discharge Capability Human Body Model (HBM) Machine Model (MM)	ESD	4000 400			V
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Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

4. Not subject to production testing.

5. Pulse Test: Pulse Width  $\leq 300\text{ }\mu\text{s}$ , Duty Cycle  $\leq 2\%$ .

6. Refer to Application Note AND8202/D for dependence of protection features on gate voltage.

TYPICAL PERFORMANCE CURVES

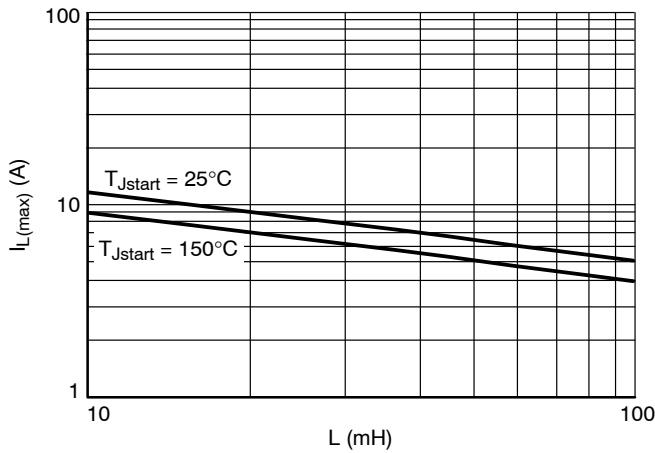


Figure 2. Single Pulse Maximum Switch-off Current vs. Load Inductance

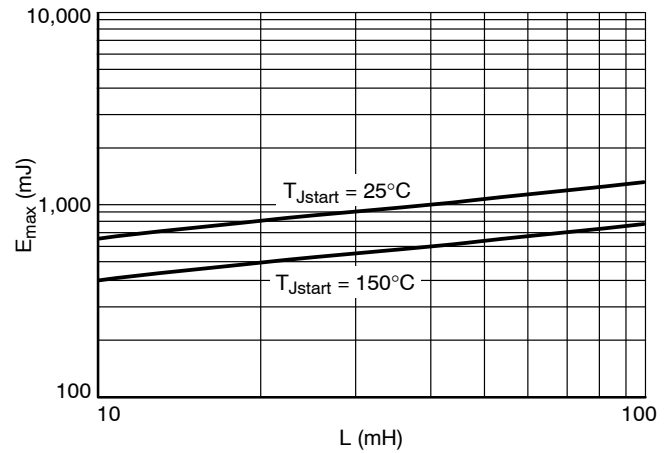


Figure 3. Single Pulse Maximum Switching Energy vs. Load Inductance

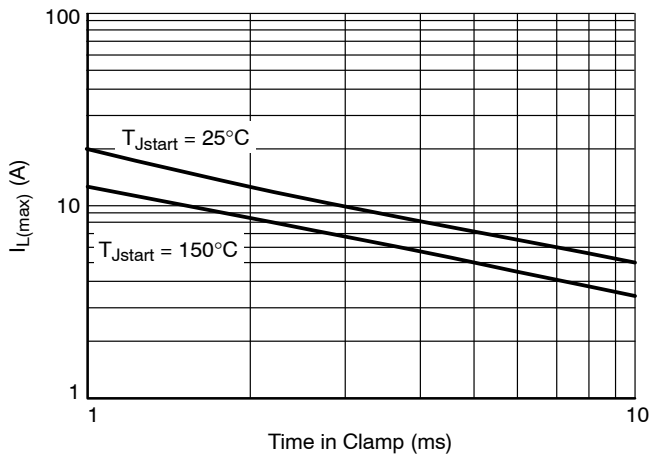


Figure 4. Single Pulse Maximum Inductive Switch-off Current vs. Time in Clamp

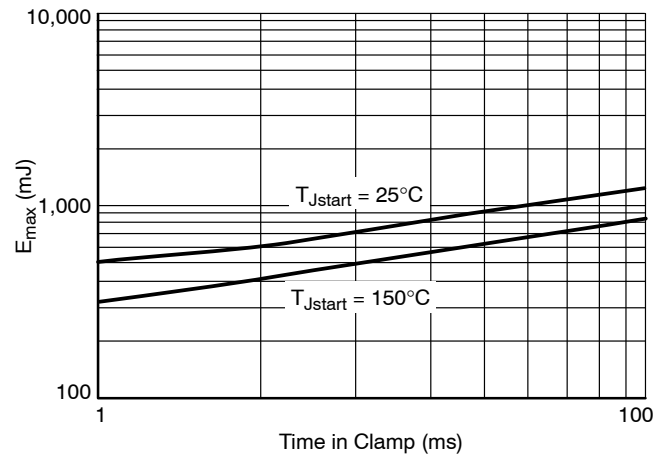


Figure 5. Single Pulse Maximum Inductive Switching Energy vs. Time in Clamp

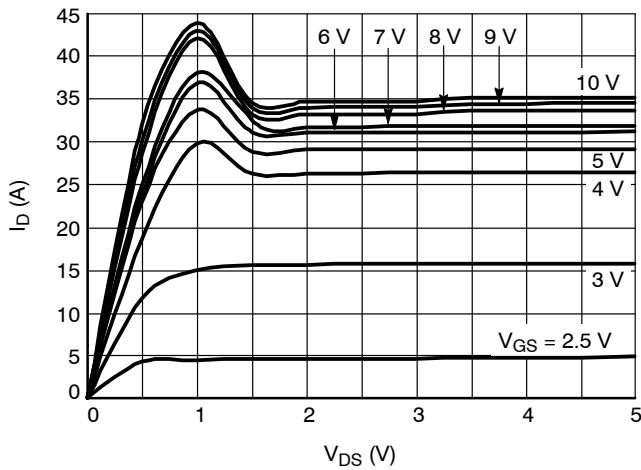


Figure 6. On-state Output Characteristics at  $25^{\circ}\text{C}$

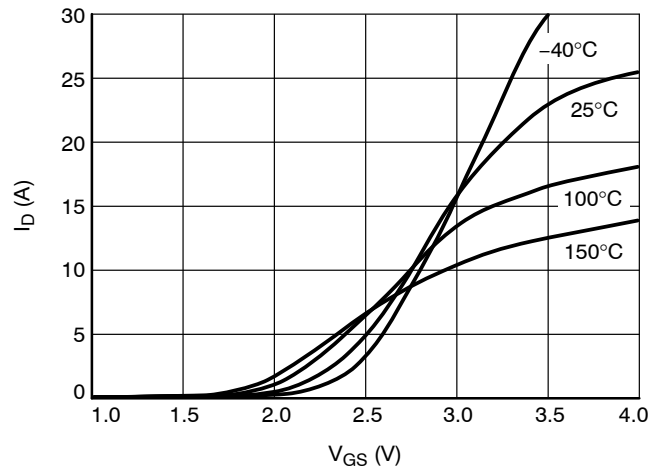


Figure 7. Transfer Characteristics ( $V_{DS} = 10\text{ V}$ )

TYPICAL PERFORMANCE CURVES

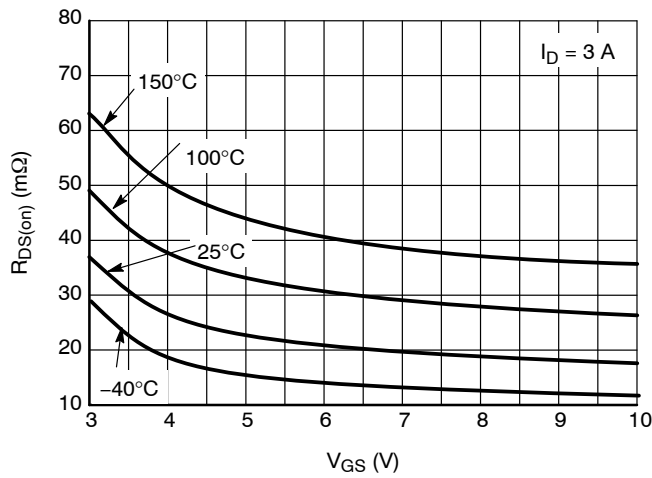


Figure 8.  $R_{DS(on)}$  vs. Gate-Source Voltage

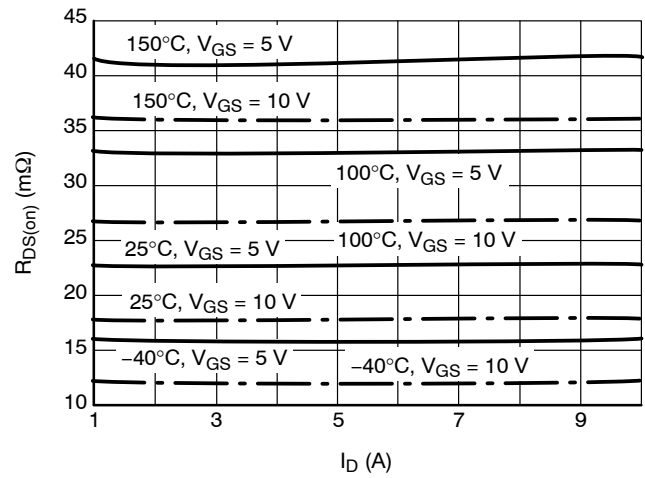


Figure 9.  $R_{DS(on)}$  vs. Drain Current

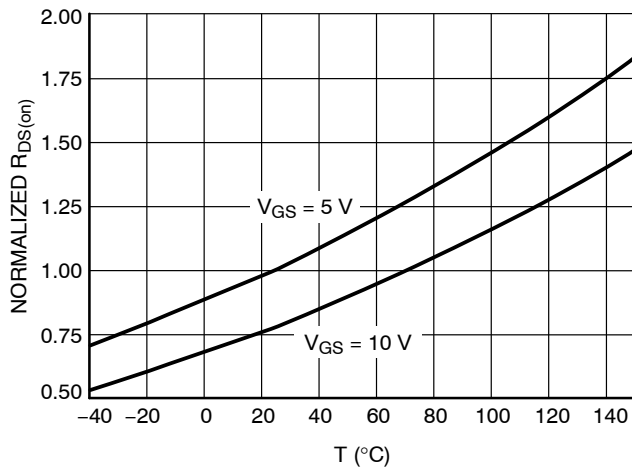


Figure 10. Normalized  $R_{DS(on)}$  vs. Temperature ( $I_D = 5$  A)

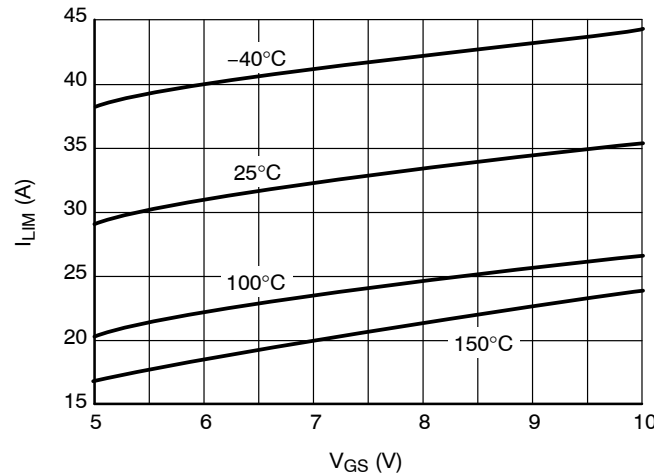


Figure 11. Current Limit vs. Gate-Source Voltage ( $V_{DS} = 10$  V)

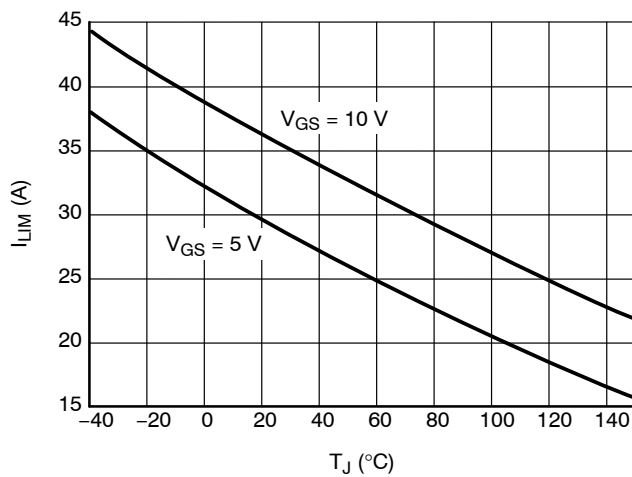


Figure 12. Current Limit vs. Junction Temperature ( $V_{DS} = 10$  V)

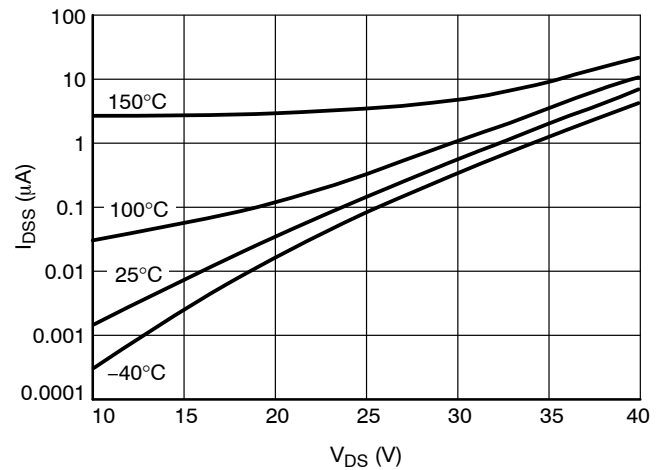


Figure 13. Drain-to-Source Leakage Current ( $V_{GS} = 0$  V)

TYPICAL PERFORMANCE CURVES

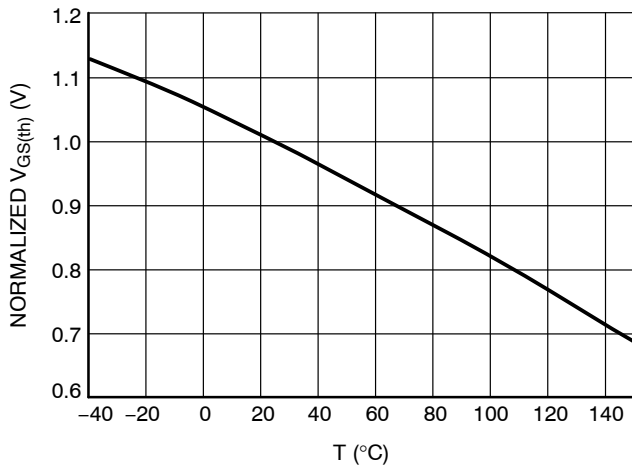


Figure 14. Normalized Threshold Voltage vs. Temperature ( $I_D = 1.2 \text{ mA}$ ,  $V_{DS} = V_{GS}$ )

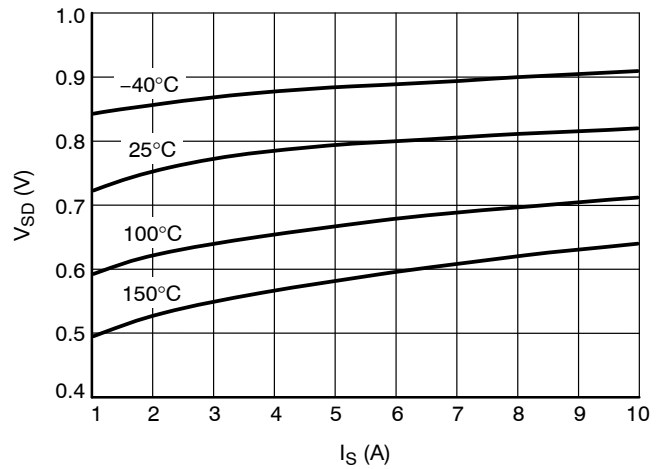


Figure 15. Source-Drain Diode Forward Characteristics ( $V_{GS} = 0 \text{ V}$ )

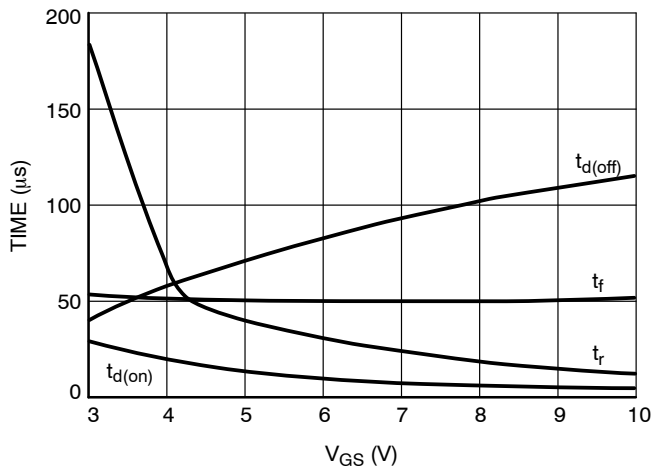


Figure 16. Resistive Load Switching Time vs. Gate-Source Voltage ( $V_{DD} = 25 \text{ V}$ ,  $I_D = 5 \text{ A}$ ,  $R_G = 0 \Omega$ )

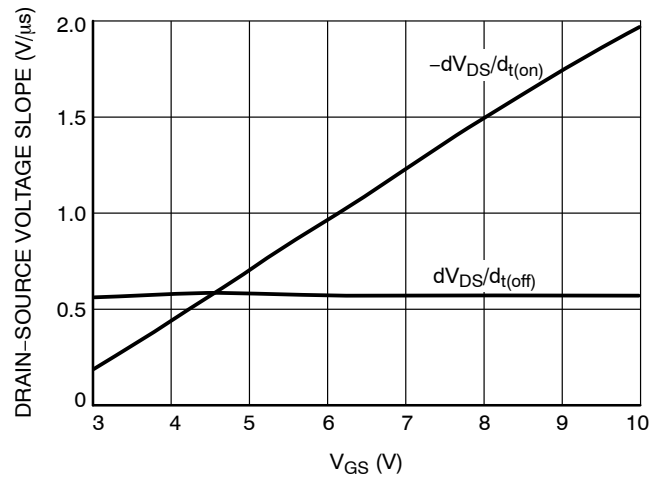


Figure 17. Resistive Load Switching Drain-Source Voltage Slope vs. Gate-Source Voltage ( $V_{DD} = 25 \text{ V}$ ,  $I_D = 5 \text{ A}$ ,  $R_G = 0 \Omega$ )

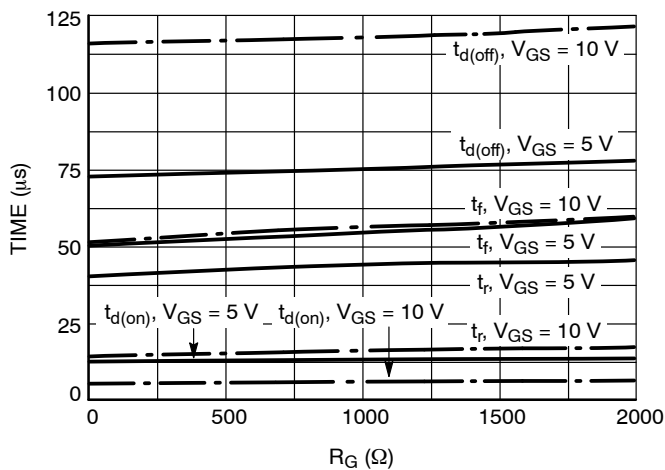


Figure 18. Resistive Load Switching Time vs. Gate Resistance ( $V_{DD} = 25 \text{ V}$ ,  $I_D = 5 \text{ A}$ )

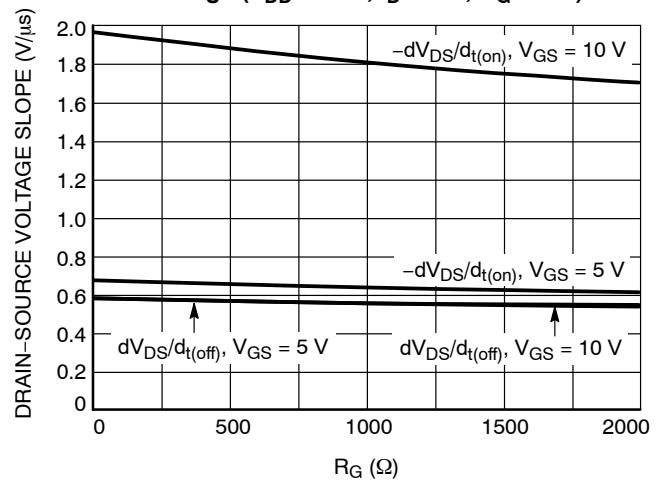


Figure 19. Drain-Source Voltage Slope during Turn On and Turn Off vs. Gate Resistance ( $V_{DD} = 25 \text{ V}$ ,  $I_D = 5 \text{ A}$ )

# NCV8401A, NCV8401B

## TYPICAL PERFORMANCE CURVES

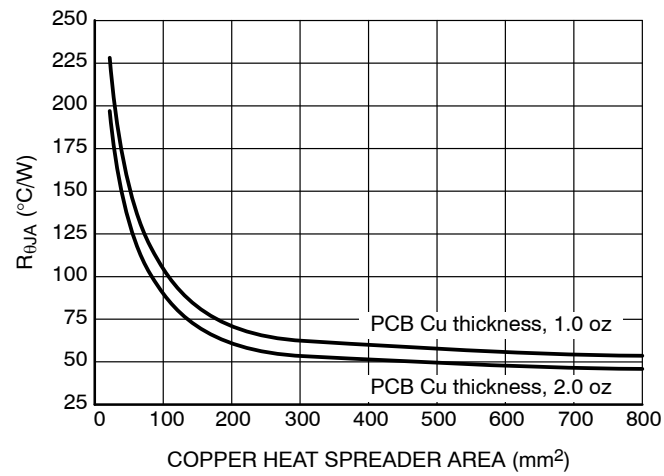


Figure 20.  $R_{\theta JA}$  vs. Copper Area

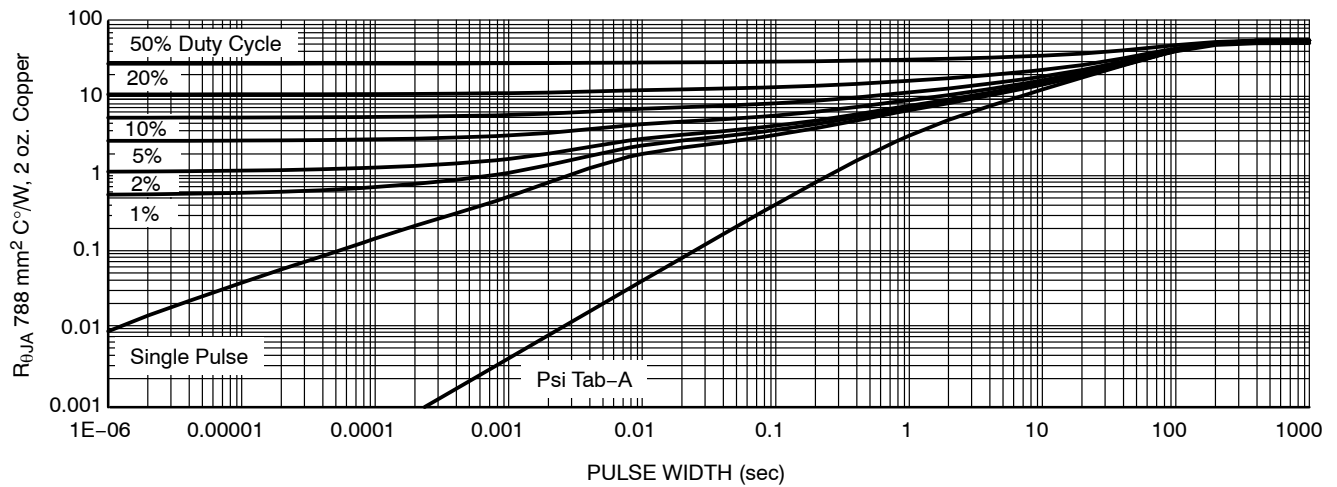


Figure 21. Transient Thermal Resistance

# NCV8401A, NCV8401B

## TEST CIRCUITS AND WAVEFORMS

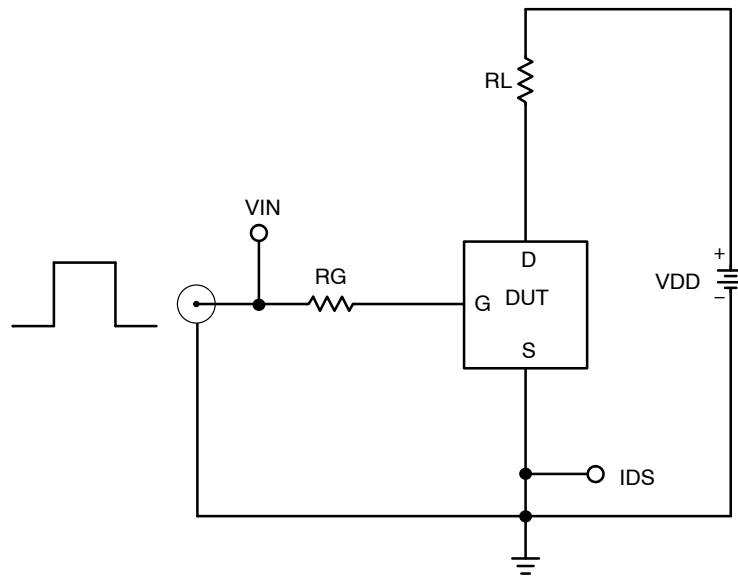


Figure 22. Resistive Load Switching Test Circuit

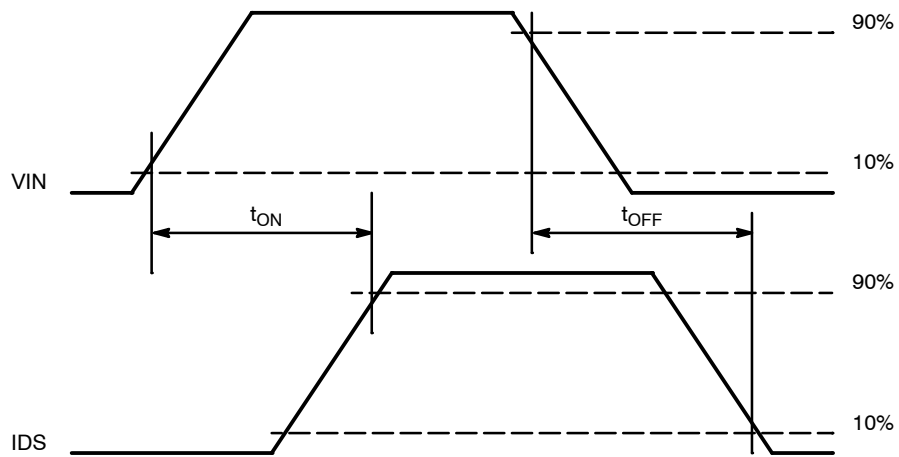


Figure 23. Resistive Load Switching Waveforms



# NCV8401A, NCV8401B

## TEST CIRCUITS AND WAVEFORMS

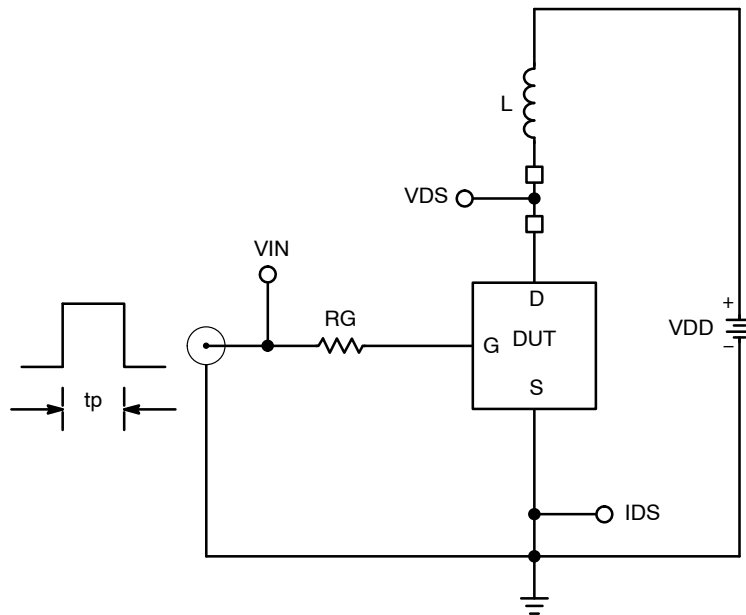


Figure 24. Inductive Load Switching Test Circuit

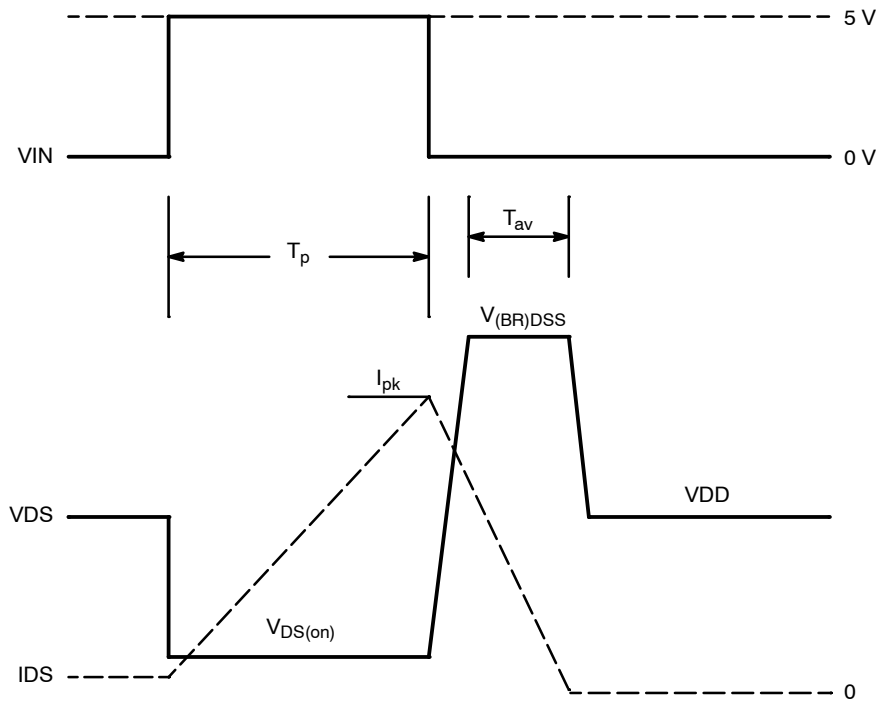
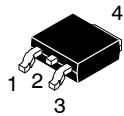


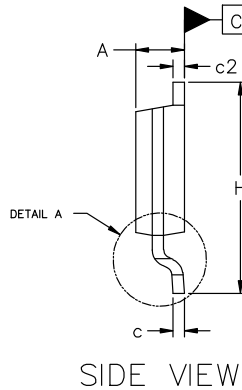
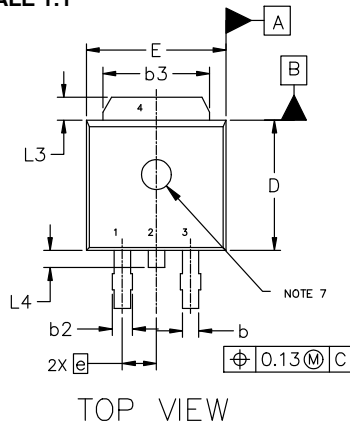
Figure 25. Inductive Load Switching Waveforms



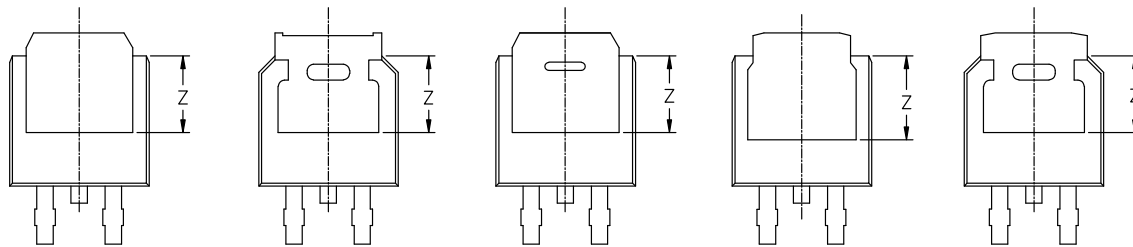
DPAK3 6.10x6.54x2.28, 2.29P  
CASE 369C  
ISSUE J

DATE 12 AUG 2025

SCALE 1:1

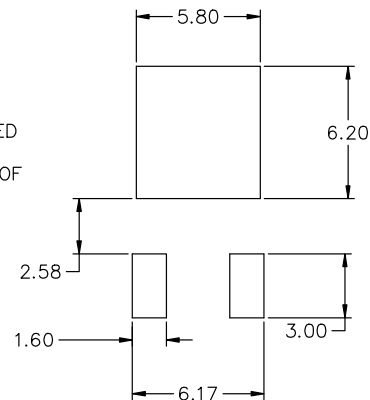
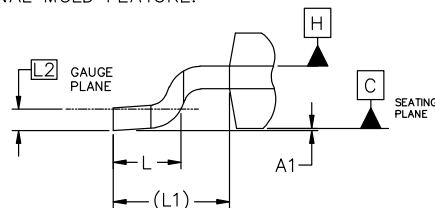


MILLIMETERS			
DIM	MIN	NOM	MAX
A	2.18	2.28	2.38
A1	0.00	---	0.13
b	0.63	0.76	0.89
b2	0.72	0.93	1.14
b3	4.57	5.02	5.46
c	0.46	0.54	0.61
c2	0.46	0.54	0.61
D	5.97	6.10	6.22
E	6.35	6.54	6.73
e	2.29 BSC		
H	9.40	9.91	10.41
L	1.40	1.59	1.78
L1	2.90 REF		
L2	0.51 BSC		
L3	0.89	---	1.27
L4	---	---	1.01
Z	3.93	---	---



NOTES:

1. DIMENSIONING AND TOLERANCING ASME Y14.5M, 2018.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS b3, L3, AND Z.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR BURRS. MOLD FLASH, PROTRUSIONS, OR GATE BURRS SHALL NOT EXCEED 0.15mm PER SIDE.
5. DIMENSIONS D AND E ARE DETERMINED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY.
6. DATUMS A AND B ARE DETERMINED AT DATUM PLANE H.
7. OPTIONAL MOLD FEATURE.



RECOMMENDED MOUNTING FOOTPRINT\*

\*FOR ADDITIONAL INFORMATION ON OUR PB-FREE STRATEGY AND SOLDERING DETAILS, PLEASE DOWNLOAD THE ONSEMI SOLDERING AND MOUNTING TECHNIQUES REFERENCE MANUAL, SOLDERRM/D.

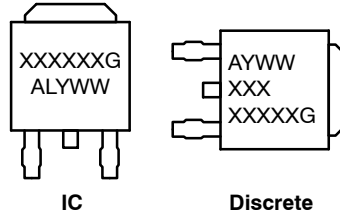
DOCUMENT NUMBER:	98AON10527D	Electronic versions are uncontrolled except when accessed directly from the Document Repository. Printed versions are uncontrolled except when stamped "CONTROLLED COPY" in red.
DESCRIPTION:	DPAK3 6.10x6.54x2.28, 2.29P	PAGE 1 OF 2

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DPAK3 6.10x6.54x2.28, 2.29P  
CASE 369C  
ISSUE J

DATE 12 AUG 2025

GENERIC  
MARKING DIAGRAM\*



XXXXXX = Device Code  
A = Assembly Location  
L = Wafer Lot  
Y = Year  
WW = Work Week  
G = Pb-Free Package

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "▪", may or may not be present. Some products may not follow the Generic Marking.

STYLE 1: PIN 1. BASE 2. COLLECTOR 3. EMITTER 4. COLLECTOR	STYLE 2: PIN 1. GATE 2. DRAIN 3. SOURCE 4. DRAIN	STYLE 3: PIN 1. ANODE 2. CATHODE 3. ANODE 4. CATHODE	STYLE 4: PIN 1. CATHODE 2. ANODE 3. GATE 4. ANODE	STYLE 5: PIN 1. GATE 2. ANODE 3. CATHODE 4. ANODE
STYLE 6: PIN 1. MT1 2. MT2 3. GATE 4. MT2	STYLE 7: PIN 1. GATE 2. COLLECTOR 3. EMITTER 4. COLLECTOR	STYLE 8: PIN 1. N/C 2. CATHODE 3. ANODE 4. CATHODE	STYLE 9: PIN 1. ANODE 2. CATHODE 3. RESISTOR ADJUST 4. CATHODE	STYLE 10: PIN 1. CATHODE 2. ANODE 3. CATHODE 4. ANODE

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